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Sustainable operations: The cutting stock problem with usable leftovers from a sustainable perspective

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ABSTRACT

This paper proposes a mathematical model and two heuristic procedures to solve the cutting stock problem with usable leftovers, relating the implications of the model with aspects considering sustainability in terms of environmental, economic and social issues. The possibility of generating leftovers that can be used or sold, reduces raw material waste during the cutting process and, consequently, increases companies' profits. By reducing waste and increasing profits, companies can become more competitive in the market. They can also integrate environmental aspects into their operational strategies and, therefore, create a better self-image and profitability, generating more jobs and contributing to a stronger local economy. We believe that the model is more likely to be adopted by smaller companies, which generally face numerous barriers but at the same time have a significant social impact, generating income and jobs. Based on the knowledge of the authors, this is the first study that relates a cutting problem with its implications for sustainability. Computational tests were performed, and the obtained results are discussed considering the win-win approach to sustainability.

1. Introduction

A positive link between operational research and sustainability has been proposed by various researchers around the world (Gonzalez et al., 2015; Gunasekaran and Irani, 2014), particularly concerning sustainable mathematical models (Brandenburg et al., 2014). A recent literature review showed that there are few studies that relationships classical problems of operational research and sustainability. This research gap was recently addressed by Jaehn (2016), who suggested, among others, that the cutting stock problem (CSP) and its relationship with sustainability as a subject needs to be developed further. This neglected gap in the literature was the foundation of this study.

The CSP consists of cutting a set of objects available in stock to produce a set of demanded items to meet the demands of customers while optimizing an objective function. This problem is essential for production planning in many industries such as paper, glass, steel bars and furniture, among others, and plays a crucial role in the current economy. These industries generally use large amounts of raw materials and there is often waste when items are cut. To minimize this negative effect, the cutting process needs to be planned. Minimizing the negative effects of the CSP can have a significant and positive effect on the corporate movement toward sustainable development.

Research on the CSP was first cited in 1939 with Kantorovich's study, which was published only in 1960. Gilmore and Gomory (1961) proposed the simplex method with column generation for a linear optimization model and solved an actual one-dimensional CSP for the first time. Gilmore and Gomory (1963) later presented a new method for the knapsack problem, which is a subproblem that arises when solving the CSP.

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